

The Institute of Lubrication Grease Institute

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Slushing Type Rust Preventives

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Tenth Annual Convention of the National Lubricating Grease Institute

A. INTRODUCTION

1. *Purpose and Plan:* This report reviews slushing type rust preventives, and includes general methods for combating rusting, uses and applications, summary of literature, patent digest, an analysis of government rust preventives and numerous evaluation tests.

2. *Evidence of Rusting:* Rusting takes place almost everywhere. It may be mild, such as the rusting of an unclean razor blade left overnight or severe enough to produce failure of heavy metal equipment which in turn may cause the shutdown of a vital process.

3. *What is Rusting?* Roughly, rusting is the conversion of iron by chemical action into a less useful form. Iron exists essentially as the oxide of iron and is prepared by the removal of the oxygen from the ore. Coke which is used for changing the ore to iron holds on to oxygen better than iron. As iron is made from the ore, the oxygen is taken from the iron by the carbon in coke leaving the metal relatively pure. The oxygen removed from the iron ore is combined with the coke to form gaseous products which may escape. Since iron has a great tendency to unite with oxygen, it combines with it to form iron oxide, the form in which it exists naturally. This combination is accelerated by the large quantities of oxygen in the atmosphere and by the presence of moisture. This conversion of the iron to the form in which it normally exists, the oxide, is called rusting or, more loosely, corrosion. The conversion of iron into other less useful forms such as caused by the reaction of acid fumes with the metal, is also called rusting.

4. *Cost of Protection against Rusting:*

The cost of protection against rusting is high. It is estimated that half of all iron and steel is painted or coated with some material for which about an eighth of a billion gallons is required at a cost of a quarter of a billion dollars. This cost may be attributed partly to beautification but most of it is for protection of the iron and steel against rusting. In addition to the main portion of the quarter of a billion dollars referred to, rusting also accounts for loss of time in shutdowns, accidents due to the failure of corroded metal, and cost of replacing equipment. It has been estimated that the total corrosion bill in normal times exceeds a billion dollars annually.

5. *A Timely Topic:* The review of this subject is timely because of the national conservation program, the shortages of iron and steel, the lack of trained man power to make replacements of corroded equipment, and the need for optimum production.

B. GENERAL METHODS FOR COMBATING RUSTING

1. *Control of Corrosive Influences:* Corrosion may be minimized or prevented by controlling the exterior corrosive influences, by increasing the resistance of the metal itself, and by the use of protective coatings. External corrosive influences may be eliminated or controlled by air conditioning for metal protected indoors. A number of industries now use air conditioning for this purpose. The pollution of the atmosphere, which is a factor in causing corrosion, can be reduced if manufacturers treat the smoke before it escapes. An educational program showing the effect of smoke on health as well as on metallic equipment should help to reduce the corrosive influences. Other methods for reducing these influences are

the treating of water in contact with metals in order to remove the corrosive components, adding inhibitors to liquids in contact with metals, and passivating the metals with special reagents.

2. *Use of More Resistant Metals:* Corrosion may be prevented or reduced by the use of metals more resistant to rusting. This may be accomplished by selecting the most suitable material for the given job or by using special rust-resisting alloys. In choosing more resistant alloys one must consider the cost. Many of the rust-resisting alloys are so costly that their applications are limited. The quantity of ordinary metals already in use in industry is of such magnitude that it would be impracticable to replace the corrodible metals in existing installations even should we develop additional economical and more resistant alloys.

(a) *Use of Best Design:* Another means of reducing corrosion is by utilizing the best available equipment design.

3. *Use of Protective Coatings:* Corrosion may be reduced by still another method, namely by the use of protective coatings. These coatings properly applied to metallic surfaces yield protection because they are generally, if designed for this specific purpose, more resistant to corrosion than the metals. The two general types of these coatings are the metallic and the non-metallic.

(a) *Metallic:* Some examples of the metallic are: (1) gold; (2) sherardizing in which iron is coated with zinc; (3) calorizing in which the coating is aluminum; (4) metal spraying of zinc, aluminum, tin, copper, brass, lead, and others; (5) hot dipping of metallic coatings such as galvanizing.

(Continued on Page 5)



Flow Characteristics of Lubricating Greases

By A. BEERBOWER, L. W. SPROULE, J. B. PATBERG AND J. C. ZIMMER

(Continued from January issue)

Plasticity values for low temperature greases, taken from Figure 19 are compared below with apparent viscosity measurement in the S.C.D. pressure viscosimeter at -40°F . The apparent viscosity values were taken at 100 sec.^{-1} rate of shear from Figure 20, giving the apparent viscosity versus rate of shear curves for the greases.

Obviously there is no simple relationship here between plasticity number and apparent viscosity. However, both tests showed the same two lubricants L and O to be the best. Since these products contain oils of different viscosities, and different amounts of the same soap, there is a possibility that a simple relationship between the data from

the two types of tests can be developed for greases having the same soap base. Either of the two methods of testing greases can be employed for investigation of low temperature characteristics for specification and control purposes.

It should be pointed out, however, that there are exceptions where neither the "Plasticity Number" or the apparent viscosity give a reliable indication of low temperature performance of a grease. Lubricant K, for example, has an extremely high, apparent viscosity and "Plasticity Number" at -40°F ., yet it has proven to be very satisfactory in certain applications at temperatures in this range. The explanation, of course, is that the lubricant channels, and only an extremely thin film remains between the moving surfaces if the equipment is first operated at ambient temperatures prior to cooling to low temperatures. Starting tests at -40°F ., for example, on a small electric motor containing a built-in 47 to 1 double reduction gear, lubricated with greases K and L show that the breakaway torque required is greater with the more viscous product K. Once the motor has started and channeled the heavier lubricant, however, it picks up speed at the starting voltage much more rapidly than with grease L, which churns through the gears.

If, however, the high starting voltage required by Grease K is used with L, the motor will have sufficient power available to overcome the drag of the less viscous lubricant and throw off excess grease from the gears. Thus, it will run at considerably higher speeds than with the heavier channeling type of grease.

The same general behavior is also encountered if the motor is operated on the heavier lubricant K at temperatures where it does not channel, but follows the gears. For example, at $+10^{\circ}\text{F}$. the motor actually runs slower with Grease K on the gears than it does at -40°F . See Table VII, Page 3.

Care will, therefore, have to be exercised to consider the possibility of channeling at low temperature or other anomalous behavior of the lubricant when making comparisons on the basis of apparent viscosity data.

All of these considerations indicate, therefore, that viscosity measurements on greases are of real value in that they express the flow characteristics in basic units and thus permit more reliable correlations and prediction of performance. While this has been illustrated by a number of examples, there are undoubtedly many more instances where viscosity data would aid in the clarification and solution of grease lubrication problems. The pressure viscosimeter which has been

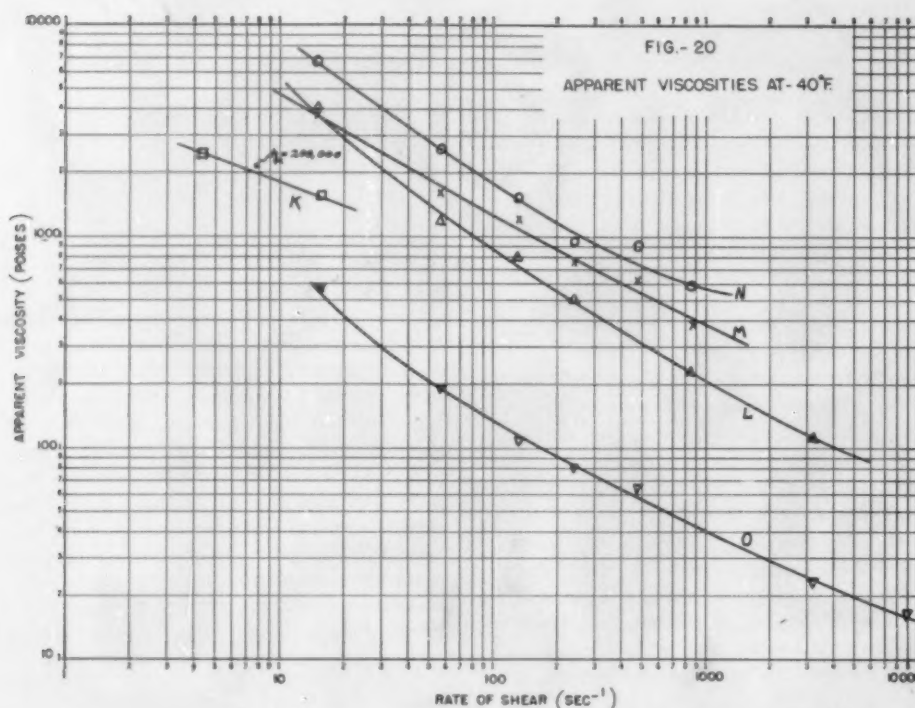


TABLE V

Comparison of Plasticity Number With Apparent Viscosities

Grease	Temperature, $^{\circ}\text{F}$ for a Plasticity Number of 20,000 (1)	Plasticity Number at -40°F	Apparent Viscosity Poises at -40°F at Sec.^{-1} Rate of Shear		
			100	500	1000
K	-18	600,000	700,000 Est.	325	—
L	-75	790	860	560	220
M	-55	3,200	1,230	—	400
N	-45	11,000	1,900	840	600
O	-113	125	139	58	40

(1) Maximum value permissible to assure a free turning bearing.

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Multiwall Paper Bags for Packaging Launching Grease

By GARDINER LANE
St. Regis Paper Co.

A Pacific coast petroleum company is now using specially constructed St. Regis multiwall paper bags for shipping launching grease. This product, composed of paraffin waxes and other residual wax derived from petroleum refining, is used for greasing ship's ways preparatory to launching. It has a melting point of approximately 135° to 137° F. and is poured into the multiwall paper bags at a temperature of 143°.

To hold the bags upright during the filling and hardening operations, wooden frames have been constructed with hinged sides to facilitate the removal of the bags after the wax is hardened. The opened bags are set in a frame and filled through a hose from the holding tank. The tops of the bags are folded over and closed by a hand stapling machine.

After the wax is hardened, the bags are removed from the frame, stacked on small flats and taken by truck to the warehouse.

The wax manufacturer as well as shipbuilders have found this type of multiwall paper bag, constructed of non-critical materials, to be a most satisfactory container for launching grease.

Because of the shortage of critical materials for the manufacture of containers and the satisfactory results obtained from the use of multiwall paper bags, intense interest is shown in the outcome of this type of container for the packaging of many petroleum products.

TABLE VI

110 Volt, 47:1 Reduction Gear Motor Tests at -40° F.

Grease	Applied Voltage (1)	Revolutions	Time Required	Final Temp.	Watts	Watt Sec. (Work)	Average Watt Seconds/Rev.
K	90 (1)	1	3 Sec.	-40	92	276	276
K	90	10	7	-40	88	616	61.6
K	90	50	22	-38	88	1936	38.7
L	56 (1)	1	72 Sec.	-40	32	2314	2314
L	56	10	192	-38.5	32	6144	614.4
L	56	50	418	-29	32	13376	267.5
L	90	1	0.6 Sec.	-40	80	48	48
L	90	10	2.0	-40	70	140	14.0
L	90	50	7.0	-40	62	434	8.7

(1) Necessary voltage to start motor applied and maintained throughout test.

TABLE VII

Test Temperature	Applied Voltage	Revolutions	Time Required	Watts	Watt Secs. Work
-40	90	10	7 Sec.	88	616
+10	90	10	37.4 Sec.	104	3890

described, and which was used for the study of the flow characteristics of greases, is designed for simplicity and flexibility of operation rather than the extreme accuracy required for determinations of absolute viscosities. It should, however, be sufficiently accurate for comparison of greases and correlation of their performance.

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"Flow Characteristics of Lubricating Greases"—Supplement

Mention was made at New Orleans regarding the possibility of extending the range of the S.O.D. pressure viscosimeter from a rate of shear of approximately 10,000 to 30,000/50,000 reciprocal seconds by shortening the capillaries used at high flow rates. In this connection we have prepared three new capillaries, the dimensions of which are given below:

Capillary No.	Radius, Cm.	Length, Cm.
A	0.0334	1.157
B	0.0232	1.207
C	0.0152	1.157

These three capillaries are used in addition to the eight which were described in the paper. As you will note the length of

the capillaries has been appreciably decreased, which permits higher flow rates or rates of shear without the generation of excessive pressure. These three short capillaries have been checked against the longer ones and the results agreed quite satisfactorily, indicating that there is no turbulence occurring due to the decreased capillary length. Data obtained using the constant rate of flow equipment described in the paper on an N.L.G.I. No. 1 grade cup grease containing a 70 SSU vis/210° F. base oil shows that the short capillaries permit extension of the range of rate of shear to approximately 30,000 sec.⁻¹. The results on this product with both the long and short capillaries are given in the attached diagram.

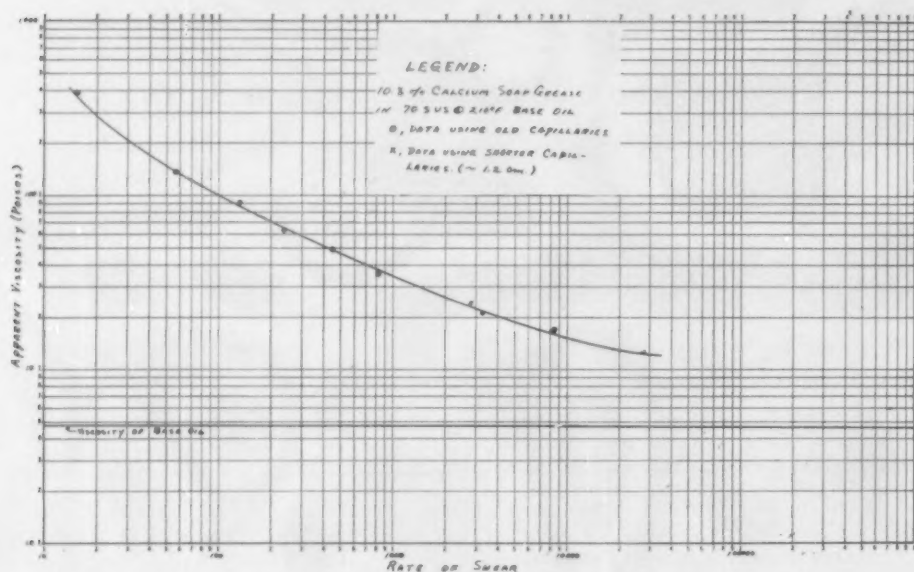


TABLE I

Capillaries Versus Grease Type

$v/t = 0.08$ cc./sec.; Temperature = 77° F.

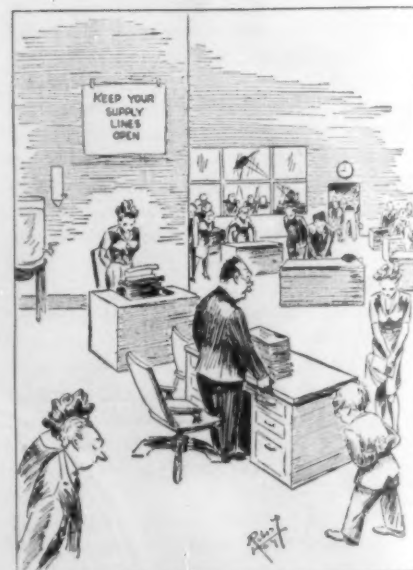
Type of Grease	1	2	1A	4	5	5A	6	7	A	B	C
NLGI 0		X		X			X	X			X
NLGI 3	X		X		X		X	X			
NLGI 6	X		X		X				X	X	
Fluid Lubricants Base Oil Having SUS/210° F.		X		X			X	X			X
A. Less Than 65											
B. More than 65 SUS/210° F.		X		X		X			X	X	

In general sufficient data can be obtained on a grease by using five capillaries out of the current total of eleven; for example, we have listed in Table I the capillaries to be employed when using National Lubricating Grease Institute's greases, grades 0, 3 and 6, and in addition fluid lubricants containing base oils having viscosities below and above 65 SSU vis/210° F.

Additional flexibility of equipment can also be obtained by replacing the constant gear reduction box with a variable speed transmission, such as a Graham variable speed unit. This permits operation at several rates of shear with one capillary and is particularly advantageous for greases containing low viscosity oils and small amounts of soap. The only precaution to be observed if a variable speed transmission is used instead of a constant reduction gear box is that a rotation counter is attached to the final drive gear from the transmission to the pump.

Publication of the very fine article on Slushing Type Rust Preventives presented by S. L. Bishkin at our Tenth Annual Convention begins in this issue. Space does not permit printing all of the Figures referred to in the text, but those omitted will appear in the next issue.

EDITOR



"Before we open the mail, let us pause the usual two minutes in silent prayer for strength to face the day's new forms and requirements."

Courtesy Fisher Scientific Co.

Slushing Type Rust Preventives

(Continued from Page 1)

ing; and (6) electroplating.

Metal spraying may be applied to large and extensive surfaces and the thickness and the composition may be varied. Metal sprayed coatings have been applied to hulls of ships, tanks, bridges, and other installations. Combinations of the coatings just reviewed may also be used.

(b) *Nonmetallic (Hard-Drying)*. Non-metallic coatings are used for the prevention or control of rusting of metallic surfaces when metallic coatings are not economical, when it is impracticable to remove previous coatings, when the material to be coated is not accessible for metallic coating application, and for other reasons.

The nonmetallic coatings are of the hard drying and the nondrying types. Chief among the hard drying types are the paints, enamels, lacquers, and synthetic plastics. Some of these coatings contain rust inhibitors and are designed primarily to protect against rusting. These may be of the transparent or opaque grades. Although a number of the hard drying coatings are de-

signed for rust protection, most of them find their chief value in decoration.

(Nondrying). Another series of non-metallic coatings, not so well known as the hard drying type, is the nondrying coatings. This series varies in consistency from solid to very thin liquids and may or may not be pigmented. This group of coatings is generally called slushing compounds because of the method by which they are often applied. Many of these, though, are applied by other means explained later. The chief function of this group of coatings is to protect against rusting. The remainder of this paper will be limited to slushing compounds. There are a number of other nonmetallic coatings which have and will continue to play an even more important role later in decoration and rust protection. These are vitreous enamels, tars, bitumens, and chemical coatings such as produced by Parkerizing and Bonderizing.

The general methods of combating corrosion which have been discussed are illustrated graphically in Figure 5.

C. USES OF SLUSHING TYPE COATINGS

Slushing type coatings are used extensively for protection against rust. For example, the

coatings are used for airplane engines, armatures, autos, metal furniture, tool joints, precision parts, submarine ballast, tanks, turbines, and for many other metallic substances. Many of the coatings are playing a vital part in the war effort. A more complete list of the uses of the slushing coatings are given in Figure 7.

D. APPLICATION OF SLUSHING TYPE COATINGS

Slushing coatings are applied by a number of methods, the most common of which are: (1) spraying, (2) dipping, (3) swabbing, and (4) brushing. The type of application is ascertained from a consideration of the consistency of the coating; type of surface on which it will be applied; the speed of application necessary; availability of equipment such as heating pots, dipping vats, spray equipment and the like; and the accessibility of the surface to be coated, for example the inside of a long tubing.

1. *Spraying*: As a rule products are sprayed only when fluid at conditions of application. Mechanical equipment is available, however, for spraying products of heavy consistency. Heated solids and semi-solids have the tendency to congeal in the

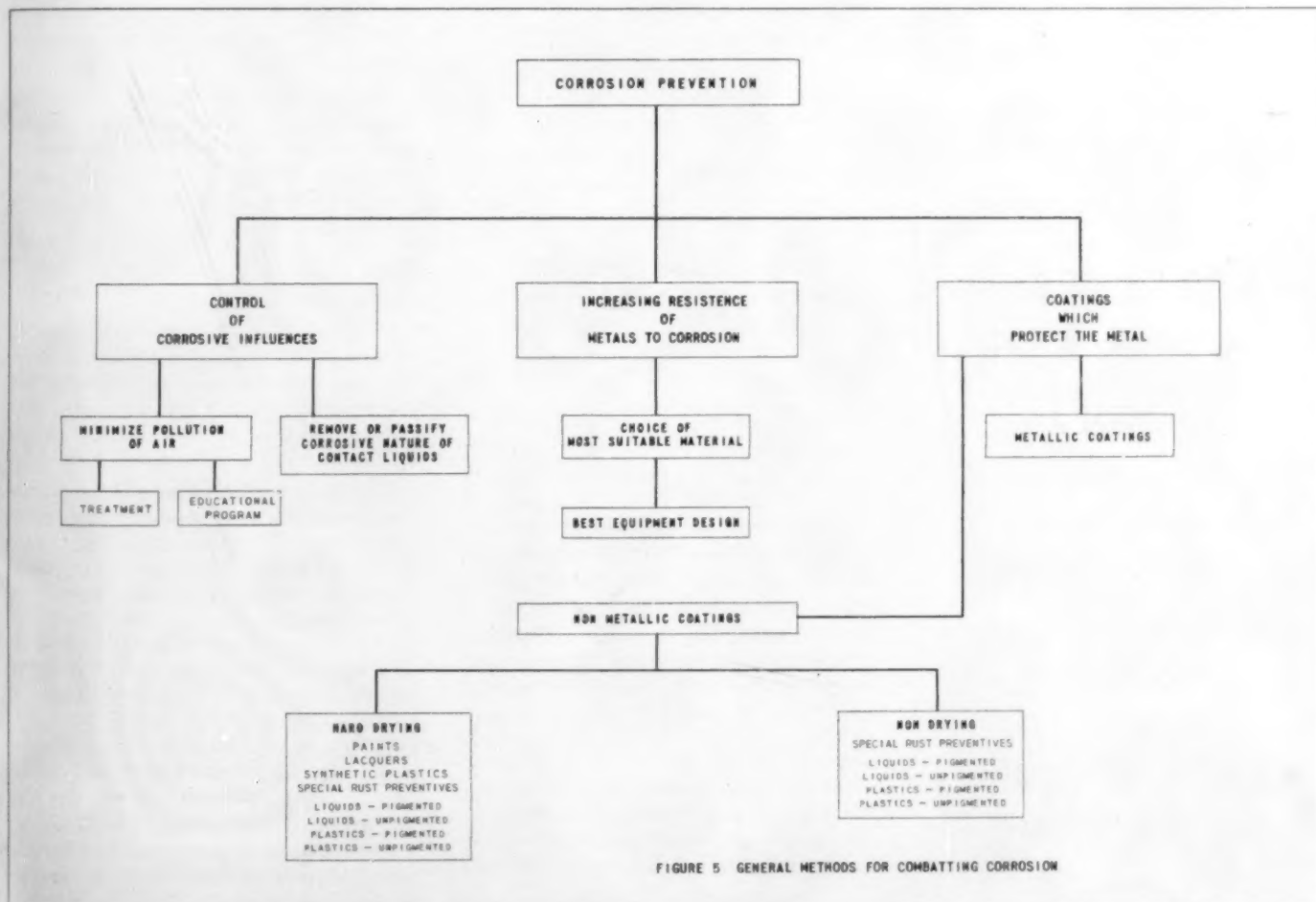


FIGURE 5 GENERAL METHODS FOR COMBATTING CORROSION

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and the Jobbing Trade*

FIGURE 7

ALPHABETICAL LIST OF SOME USES FOR SLUSHING TYPE RUST PREVENTIVES

Armatures	Machinery, in
Autos	Storage
Battery Terminals	Textile
Bearings	Needles, Sewing
Blades, Saw	Machine
Razor	Nuts and Bolts
Bridges, Metal	Parts, Precision
Buildings, Metal	Motor
Cables	Pipe, Above and
Cans, Ice	Underground
Chains	Stove
Car Journals	Plate, Boiler, after
Cars, Railway	Pickling
(underframes and	Rings, Piston
undercarriages)	Rods, Sucker
Tank	Scales
Castings	Shells
Coils, Condenser	Signs, Metal
Cartridge Clips	Springs, Bed
Dies	Steel, Auto Body
Drives, Sprocket	Bar
Drums, Steel (ex-	Exposed to Acid
terior and in-	Fumes and Se-
terior)	vere Climatic
Engines, Aircraft	Conditions
Automotive, In-	Polished
terior of	Polished Bar
Equipment, Marine	Stock
Fences	Structural
Fire Arms	Submarine Ballast
Fire Escapes	Tanks, Water, In-
Furniture, Metal	terior and Ex-
Gears, Exposed	terior
Guns	Vapor Space
Joints, Tool	Tools, in Storage
Machined Surfaces	Turbines, Inside of
	Valves
	Vehicles
	Vessels, Hulls of

spraying equipment. This is minimized by the maintenance of elevated temperature on all piping through which the compound is forced. Often heavy slushing compounds are diluted with solvents to reduce the consistency to that used normally in spraying.

2. *Dipping*: The method of dipping is most easily used with slushing compounds which are fluid at temperature of application. This process, however, is used frequently with other slushing compounds by warming the coatings. Caution should be exercised when slushing compounds containing low flash point solvents are heated. Care should also be taken not to heat the compounds too long nor too rapidly for some

*References—see appendix.

compounds will deteriorate under these conditions.

Both small and large parts may be dipped. Large objects may be placed directly into dipping tank, whereas small objects are generally placed in baskets or held by some fastening device during the dipping. The articles dipped should remain in the tank until they are warm and in order to produce a thin coating, the dipped articles should remain in the tank until equilibrium is reached.

3. *Swabbing*: Swabbing is easily accomplished and for this reason is commonly used. The heavier slushing compounds, especially the semi-solids and solids, must be heated before application. One method of swabbing is in which the coating is heated, poured into a garden sprayer, poured on the pipe line and the coating swabbed with a rag.

4. *Brushing*: Brushing is generally used for light liquids. As in the other methods, heavier coatings may be warmed and then applied.

5. *Other Methods*: A number of other methods based on one or more combinations of the procedures just described are used for the application of the slushing coatings. One of these is in which flat steel sheets are treated with slushing coatings by a roller method as they pass through processing grooves.

Best results in application are secured from slushing coatings when the heavier consistencies are applied in molten state or in solution. The reason for this is that under these conditions a continuous film is produced.

E. LITERATURE

1. Articles and Books

(a) *Articles*: Only a limited number of articles on slushing compounds are in English. Reference to some of these are shown in the appendix of this paper. The essential information in a number of the articles reviewed is summarized below.

One of the earlier investigations on slushing compounds was made by the Paint Manufacturer's Association of the United States. (A)*. This article commented on the nature of slushing compounds, gave some ordinary uses for the compounds, suggested a formula (petrolatum 50 pounds, zinc dust 30 pounds, aluminum powder 5 pounds, and mineral spirits 5 pounds, optional) and also reviewed Federal specifications 239 and 293. Compositions of rust preventives found in all the literature reviewed are shown in Figures 18 to 22 inclusive, however, the suggested formula given above was omitted.

Another early investigation on slushing type rust preventives was made by the Bureau of Standards in 1920 (C)*. This ref-

FIGURE 18
COMPOSITIONS OF SLUSHING TYPE RUST PREVENTIVES
Coatings Containing Petrolatum

Other Principal Ingredient	Amount Petrolatum	Other Ingredients	Use	Reference
Aluminum Soap of Coconut Oil		Paraffin Potassium Hydroxide Potassium Chromate	General	73
Aluminum Stearate			Temporary Protection Airplane Motors	29
Beeswax or Paraffin		Heavy Mineral Oil & Gasoline may be substituted for the petrolatum. Beeswax may also be used.	General	76
Lactone and Ester		Mineral Oil or Aldehyde or Ketone	Removal and Prevention	79
Lanolin		Spindle Oil Machine Oil, etc.	Steel	15
Oil, Petroleum 85%	5%	Drying Oil 10% Drier	Galvanic cell Terminals	55
Oil, Heavy Refined		Rosin, Paraffin and Salt	Battery Terminals	86
Paraffin		Resin or mixture with Paraffin; jute impregnated with this composition as cover	Lead Covered Electric Cables	54
Paraffin Wax		2% Lead Resinate	Ferrous Material	88
Pine Fatty Acids			Roll Strip Steel During Handling	14
Red Lead 29%	45% (Vaseline)	Asphaltum 25% Odorant 1%	General Use	77
Rosin		or Zinc Naphthenate		19
Rosin—20 grams	100	Kerosene 10cc		C(Pg. 22)
Rosin—6 pts.	50	3 pts. Candelilla Wax		C(Pg. 23)
Rosin—5 pts.	50	Carnauba Wax—2 pts.		C(Pg. 23)
Sodium Carbonate 64 pts.	80 pts. (Pet. Jelly)	Oil of Cedar—1	Battery Terminals	52
Sodium Nitrite 50 grams to	2 Kilos (Vaseline)	(or glycerol)		10
White Lead 5 pts.	5 parts	Lube Oil—1 part	Iron or Steel or other volatile material	75

erence reviewed the nature of slushing compounds, and showed that certain semi-solid consistency greases made of petrolatum and small proportions of wax and rosins were effective. Suggested specifications were given. These are found in Figure 18 and also in reference C, Pages 22 and 23.

Researches conducted at the National Physical Laboratory in 1925 showed that crude lanolin was an effective rust preventing material (D)*. More comprehensive tests were published by the same laboratory in 1934 (B)* in which it was reported the crude lanolin dissolved in white spirits or solvent naphtha was effective as a rust preventive. It was also shown that small amounts of specified dyes were helpful in

identifying objects that had been coated. The quality of lanolin was reviewed and it was pointed out that the acidity of lanolin did not have a great effect on its protection of steel, but that lanolin with low acidity was better. Experiments in which small quantities of waxes were introduced into the composition of the slushing coatings showed that they made the coatings harder and therefore less affected by frequent handling. Comparative tests were also conducted on lanolin and petrolatum coatings from which it was concluded that the lanolin coatings were better. Other references showed that the petrolatum blends were superior.

(To be continued)

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